Alberta

COMMUNITY AND
OCCUPATIONAL HEALTH

AN ANALYSIS OF THE WCB CLAIMS EXPERIENCE AND POTENTIAL HEALTH HAZARDS IN THE ALBERTA OIL SANDS INDUSTRY, 1978-1983

Occupational Health & Safety

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Blair MacKinnon
Research Branch
Occupational Health
& Safety Division

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FOREWORD

The oil sands industry could potentially become one of the major industries in the Alberta economy. The long range economic prospects for the vast deposits of oil sands remain promising in view of the steadily declining known reserves of conventional oil in Alberta. In addition, proposed new oil sands developments at Peace River and Cold Lake and a number of pilot projects developing new recovery techniques indicate future growth.

In 1982-1983, the Executive Committee of the Occupational Health and Safety Division (OHSD) targeted the oil sands industry as a priority area for division-sponsored research and preventive programs. This report provides information regarding some of the known and potential occupational hazards in this industry. In general, more is known about the safety hazards than the health hazards of mining and processing oil sands. It is hoped that this report will stimulate further research on the potential health hazards of this industry.

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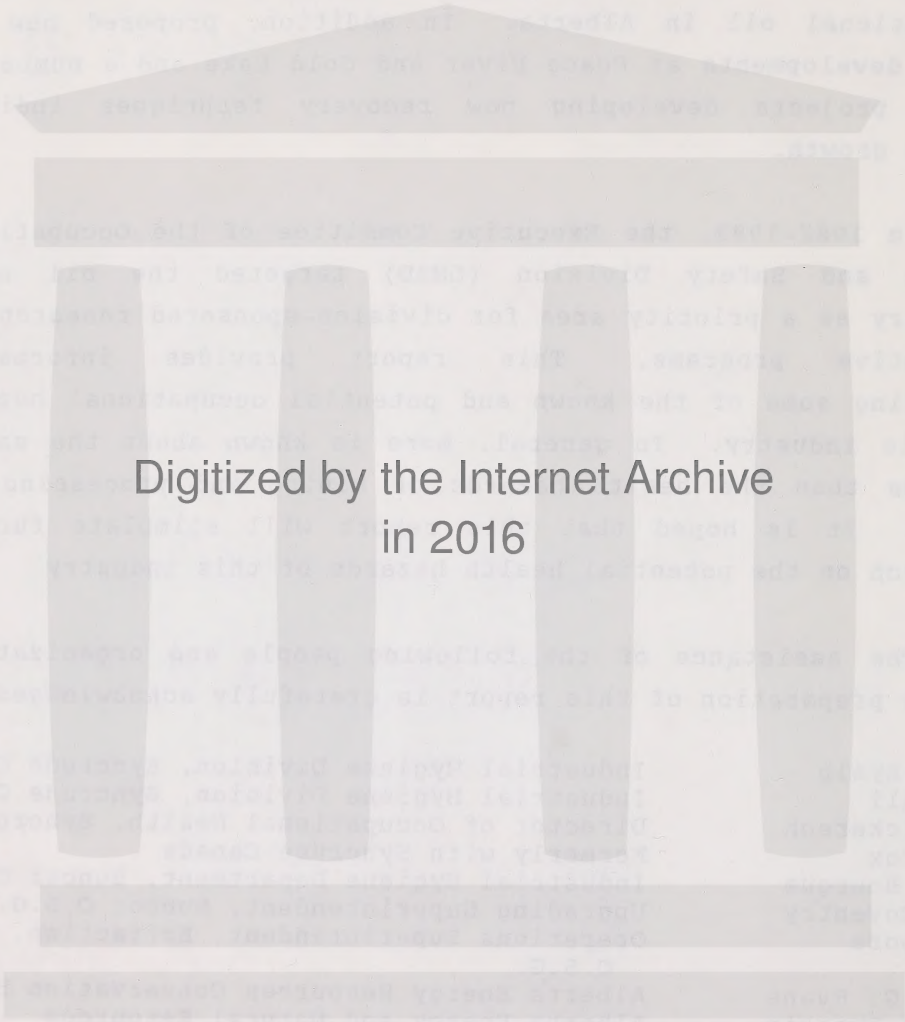

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OVERVIEW

This report summarizes the Workers' Compensation Board (WCB) claims experience of the Alberta oil sands industry from 1978 to 1983. Information is also included on fatalities associated with oil sands activity which were investigated by the Occupational Health and Safety Division.

Details of synthetic crude production up to 1983 are provided along with information on the size and extent of the oil sands reserves. Anticipated future developments in the oil sands industry are also discussed.

A description of some of the potential health hazards of the oil sands, based on a review of the literature and discussions with researchers in the area, is also included. As the oil sands industry is relatively new and extraction technologies are constantly being developed, there are still many questions to be answered about potential worker health problems.

HIGHLIGHTS

- The Alberta oil sands contain potentially recoverable reserves of synthetic crude oil equal to one-third of the world's known recoverable crude oil reserves.

- During the period 1978 to 1983, the annual production of synthetic crude oil almost tripled, from 21 million barrels in 1978 to 58 million barrels in 1983.

- The estimated number of Workers' Compensation-covered employees in the oil sands industry ranged from a high of 8,558 in 1980 to a low of 4,676 in 1983. These estimates do not include employees of contractors in other related industries working on oil sands sites. Suncor and Syncrude are the two largest companies in the oil sands industry.

- The number of experimental oil sands projects has increased dramatically from 16 in 1982 to approximately 70 in early 1986. There are presently six commercial oil sands operations.*

- Ten fatalities at the sites of oil sands operations were investigated by the Occupational Health and Safety Division between 1976 and 1983. Three fatalities involved workers in the oil sands industry while the remaining seven involved sub-contractors carrying out related operations in other industries (e.g., construction, heat treating of metal, etc.).

* ERCB, February, 1986.

- The WCB lost time claim rate of the oil sands industry is quite low, averaging about 2.2 claims per 100 man-years worked. However, the lost time claim rate has steadily increased from 1.9 in 1980 to 3.6 in 1983. This rate is substantially lower than the provincial average lost time rate (7.5 claims) and the lost time claim rate of most oil and gas industries and surface coal mining for the same period. (The actual lost time claim rate for the oil sands industry may be higher than estimated as the claims and estimated man-years worked of sub-contractors to the industry were not included.)

- The lost time claim rate per million barrels of bitumen produced declined from 2.4 claims in 1978 to 1.8 in 1980. The lost time rate then increased to 3.6 in 1982 and again declined to 2.1 in 1983.

- The *back* was the most frequently injured body part accounting for 29% of the lost time claims. Incidents involving *overexertion* accounted for 21% of the lost time claims followed by *bodily reaction* incidents with 15%.

- The most frequent sources of injury were *working surfaces* (18%), *bodily motion* (15%) and *metal items* (14%). The most common type of injury was *sprains and strains*, accounting for almost one-half of the lost time claims.

- *Construction* occupations and *mechanics* each accounted for 20% of the lost time claims.

- Occupational diseases (see page 30 for explanation) accounted for 74 (8.8%) claims, a higher proportion than is generally found for lost time claims across all industries. There were 53 (6.3%) claims involving exposure to toxic substances.

- Workers in the oil sands industry face a number of potential health hazards such as exposure to *hydrogen sulfide*, *carbon monoxide*, *various hydrocarbons* and *coke dust*. Long term studies on the effects of these potential health hazards are lacking. In addition, the actual seriousness of such hazards will vary for normal operations versus maintenance operations.

- *Vanadium*, a heavy metal present in bitumen and found in higher concentration in fly ash does not appear to be a health hazard to oil sands workers. However, it may be a potential health hazard at the proposed vanadium extraction plants.

- A number of oil sands developments, including *in situ* projects, are being proposed or currently developed. They include a $1.5 billion *in situ* plant proposed by Dome Petroleum at Primrose Lake and a $4 billion oil sands plant proposed by Can-Star, NOVA and Petro-Canada in the Fort McMurray area. Presently, eight major *in situ* oil sands projects are proposed including the Esso Resources Cold Lake-Clearwater plant which is already producing 19,000 barrels per day.

INTRODUCTION

Background

Canada is one of the largest per capita users of oil in the world. Of the 1.8 million barrels of oil consumed by Canadians every day, approximately three-quarters is domestically produced. The high rate of production required to maintain this supply is rapidly depleting Canada's known reserves of conventional oil.[1]

According to Alberta Energy and Natural Resources, about 85 percent of the oil produced in Canada comes from Alberta. Of this amount, 21 percent is used in Alberta, 65 percent in the rest of Canada and the remaining 14 percent is exported. The amount exported from Canada is roughly equivalent to the oil imported for use in Eastern Canada.

However, a major future source of oil lies in the oil sands deposits of Alberta, which contain potentially recoverable reserves of synthetic crude oil equal to one-third of the known recoverable crude oil reserves in the world. Using existing technologies (which include *in situ* extraction procedures), the oil sands could supply Canada's needs for 36 years and Alberta's needs for 250 years at the present rate of consumption.

In view of the steadily increasing amounts of synthetic crude produced from the oil sands each year and the oil sands

[1]Robert E. McRory, Oil Sand and Heavy Oils of Alberta, Alberta Energy and Natural Resources, 1982, p.7.

development projects scheduled in the near future, the oil sands industry is becoming an increasingly important sector of Alberta's oil industry.

Definition of Oil Sands Industry

The oil sands industry is defined using the Statistics Canada 1960 Standard Industrial Classification (SIC) and includes the following industries:

1. 6600 - Processing of Oil from Tar Sands
2. 6601 - Oil Sand Research and Development
3. 6602 - Bituminous Sand Mining for Oil*

Only claims charged to these three industry codes were included in the Workers' Compensation lost time claims analyses presented in this report. See Table 1 for the number of employers assessed in the oil sands industries.

Data Sources

Information in this report comes from a number of different sources. The claims data are based on all new claims reported to the WCB in each year (1978 - 1983) and settled by March 31 of the following year. Claims which were reported but not settled during this time period were excluded from the analyses. Also excluded were lost time claims charged to and man-years estimated for subcontractors doing construction and related work on the oil sands sites. Since these contractors may work at other sites in the province, it is impossible to separate the claims at oil sands sites from claims occurring at

*Note: From 1981 onward, the WCB has not classified companies in industry 6601. All WCB accounts formerly in this industry have been classified under industry 6600.

other sites. Often the WCB charges claims to the head office site rather than the actual site where the incident occurred. The analyses of work-related injury and illness characteristics were restricted to lost time claims as information for these claims is most complete. In addition, due to changes in reporting requirements, information on the total number of medical aid claims was not available for 1982 and 1983.

Data on claim rates were prepared by the Occupational Health and Safety Division. The rates are based on man-years worked in each industry which have been estimated from wage and payroll data submitted to the WCB. Information on fatalities is based on fatality investigations conducted by the Occupational Health and Safety Division. Oil sands production data (1978 - 1983) are from the Energy Resources Conservation Board. Background information on oil sand mining, extraction upgrading and processing procedures was obtained during tours of Suncor and Syncrude as well as from various oil sands publications and personal communication with company officials.

Information on potential health hazards was derived from a review of the relevant literature and conversations with OHSD experts, other government agencies and industry experts. Details of future development projects in the oil sands industry are from Alberta Economic Development and newspaper articles. The Research Branch wishes to thank Syncrude and Suncor for their assistance during informative visits to their oil sands plants.

TABLE 1

NUMBER OF COMPANIES ASSESSED BY THE WCB IN THE OIL SANDS INDUSTRIES, 1978 - 1983

INDUSTRY	1978	1979	1980	1981	1982	1983
Processing of Oil from Tar Sands	3	5	6	8	8	7
Bituminus Sand Mining for Oil	3	3	4	7	7	5
Oil Sand Research & Development	3	2	2	-	-	-
Total	9	10	12	15	15	12

Source: Occupational Health and Safety Division Report WHOH6102, 1978-1983. Number of man-years is estimated from wage and payroll data reported by employers to the WCB.

OIL SANDS: DEFINITION, LOCATION AND EXTRACTION TECHNIQUES[2]

Bitumen

Bitumen is defined "as a naturally-occurring viscous mixture of hydrocarbons, which , in its natural state, is not recoverable at a commercial rate through a well".[3] Thick, black, tar-like bitumen has the consistency of cold molasses and pours very, very slowly. Bitumen is composed of an average of 82.2% carbon, 10.4% hydrogen, 0.94% oxygen, 0.36% nitrogen and 4.8% sulphur. The remaining content is made up of small amounts of dissolved methane and traces of H_2S, along with trace amounts of heavy metals such as vanadium, nickel and iron.

After the carbon content in bitumen is reduced and more hydrogen is added, the product is called "synthetic crude oil" because it does not occur naturally in the ground but is produced from chemical alterations to the bitumen. Synthetic crude has properties similar to a high grade conventional crude oil.

Location

Bitumen saturated sand occurs in the four major oil sands reserves in Alberta: Peace River, Athabasca, Wabasca and Cold Lake. Together they cover an area of almost 77,670 square kilometres. The oil sands deposits consist of a mixture of

[2]Robert E. McRory, Oil Sands and Heavy Oils of Alberta, Alberta Energy and Natural Resources, 1982, p. 13-20, 49-54.

[3]Ibid, p. 14.

sand, clay, water and bitumen. Each grain of sand is surrounded by a layer of water which, in turn, is surrounded by oil. This layer of water makes the hot water separation process practical. (see page 11)

The oil sands occur in layers at different depths in each deposit. The shallower oil sands deposits are accessible to surface mining methods such as those currently being used at Suncor and Syncrude. The overburden (sand, gravel and shale) which covers the oil sand deposit is first removed. The oil sand is then mined and processed to separate the bitumen from the sand. According to the most recent ERCB guidelines, the economical feasibility of surface mining methods is a linear function of the bitumen saturation and the overburden thickness. Hence, the higher the bitumen saturation, the greater the depth of overburden which can be economically removed. Surface mining methods can still be economically feasible up to depths of 95 meters if the bitumen saturation is as high as 12%. Of course, this function is dependent upon the price structure of conventional oil.

Mining Techniques

Mining at Suncor is done by large, self-propelled bucketwheel excavators as high as 10-storey buildings. They are electrically powered and move on six wide crawler tracks. Each carries a wheel with ten buckets on the end of a boom. As the wheel revolves, each bucket bites a chunk out of the mine wall and deposits sand on one of the two conveyor belts which extends the length of the excavator. This moves the sand to the system that carries it to the extraction plant.

One of the excavators operates from a bench (or platform) at or just above the floor of the mine and the other from a bench about 65 feet above the first. The bucketwheels can reach to the top of the 65 foot mine wall, across a section 120

feet wide. Once that area has been mined, the excavator moves to an adjacent location and starts again.

Unlike Suncor, the oil sand at Syncrude is mined by four walking draglines (so called because they move in a walking fashion on legs rather than moving on treads), two located on each side of the open mine, working outward. The huge booms on the draglines have the capacity to move 84.4 million tonnes of oil sand and waste material a year. The draglines operate by dropping a bucket suspended from the boom into the oil sand and scooping it up. The contents of the bucket are then piled into a long row of sand (windrow) that runs parallel to the mine cut. Oil sand is removed from the windrow and carried to the conveyor system by bucketwheel reclaimers, similar to those at Suncor but about twice as long.

Extraction and Upgrading Operations[4]

This section provides a brief description of the extraction and upgrading of bitumen. Oil sand consists of a mixture of bitumen, sand grains and water. Bitumen, which is a thick dense petroleum substance that impregnates the oil sands, surrounds the water layer covering the sand particles. Sand grains constitute 83% of the weight of oil sands, with bitumen and water accounting for the remaining 17%.

Extraction

The oil sands is moved by conveyor belt to the extraction plant where the bitumen is separated from the sand. First the

[4]Ibid, p. 36-44.

Biophysical Impact Assessment for the New Facilities at the Syncrude Canada Ltd. Mildred Lake Plant, 1984.

oil sand is mixed in huge revolving drums with hot water, steam and a caustic such as sodium hydroxide. The water film between the sand grain and the bitumen ruptures and small globules of bitumen are aerated to form a liquid slurry. This slurry is screened to remove rocks, clay and oil sand lumps and is then pumped into separation tanks where most of the bitumen rises to the surface as a froth. The sand sinks to the bottom and is pumped away along with most of the water.

Bitumen from the separation treatments is heated and diluted with naphtha to make it flow more readily. It is centrifuged to remove coarse solids, clays and remaining water. At Suncor, the bitumen is mixed with naphtha and stored as diluted bitumen. The naphtha is removed by the diluent recovery unit in upgrading before the bitumen is upgraded into synthetic crude oil. At Syncrude, the clean bitumen is withdrawn from the centrifuge, run through a diluent recovery unit to remove the naphtha and then stored in heated tanks to await upgrading into synthetic crude oil. The clean bitumen is withdrawn from the centrifuge, run through a diluent recovery unit to remove the naphtha and then stored in heated tanks to await upgrading into synthetic crude oil.

The sand, clay, water and bitumen from the extraction units and the centrifuges are called tailings. The tailings are pumped to tailings ponds - water storage areas contained within dykes.

Upgrading

Upgrading refers to the process which converts the heavy bitumen into a refineable product by increasing the hydrogen-to-carbon ratio. Bitumen is not suitable for transport by pipeline or refining because of its high viscosity and because it contains high amounts of sulphur, nitrogen and metals.

In the cokers bitumen is heated and broken down or cracked into its different fractions. The heaviest fraction, "coke", separates as a solid. The remaining lighter fuel elements - naphtha, kerosene and gas-oil - are drawn off as vapors. (Note: Suncor's coking process produces four main components: light process gas, naphtha, kerosene, and gas-oil. Syncrude's process produces three components - process gas, naphtha and gas-oil.) These vapors rise through a fractionating tower where they are cooled and condensed into liquids. Different fractions condense at different levels of the tower. The heavier gas-oils come from the bottom and the lighter fractions from the top. The process gas is the fraction that does not condense.

Liquid hydrocarbon portions are treated with hydrogen to remove the sulphur and the treated gas is returned to the upgrading process. The clear liquid products are stored individually until they are recombined for shipment as synthetic crude oil. The hydrogen sulfide removed from the gas and liquids is converted to elemental sulphur and stored until it can be marketed.

Most of the upgrading processes are enclosed systems, thus reducing the chance of worker exposures. However, maintenance procedures may present more of a potential for exposure to acute hazards. (See page 31 for toxicity studies of oil sands products).

In situ Techniques

About 90% of the oil sands deposits are buried too deep to be mineable by surface extraction methods. Therefore, this vast reserve of oil sands can only be developed by *in situ* processes which separate the bitumen from the sand in place and thin it enough to flow.

Research over the years has shown that thermal *in situ* techniques increase the flow of bitumen, allowing it to be separated from the sand and then pumped to the surface. Both fire and steam methods can be used to recover bitumen. Each has some advantages and disadvantages. No single method of *in situ* recovery can be used on all the oil sands deposits because the viscosity of the bitumen and the composition of the oil sand formation varies from deposit to deposit and within deposits.

As of early 1986, there were approximately 70 experimental projects operating in the four oil sands deposits. The majority were testing various *in situ* techniques such as thermal recovery techniques and methods of separating bitumen and water.

OIL SANDS PRODUCTION

Production of synthetic crude oil from bitumen has more than doubled from 21 million barrels in 1978 to 58 million barrels in 1983. Syncrude's production began in 1978. The amount of synthetic crude oil produced represented approximately 10% of the supply of conventional crude oil produced in Alberta each year. (See Figure 1 and Table 2). (See Table B1 in Appendix B for detailed production data for Suncor and Syncrude).

TABLE 2

ALBERTA OIL SANDS PRODUCTION
(1978 - 1983)

	BARRELS OF BITUMEN[1]	BARRELS OF SYNTHETIC CRUDE OIL[2]
1978	29,630,227	21,044,339
1979	46,625,414	35,419,848
1980	63,910,400	48,063,916
1981	55,130,886	41,907,127
1982	59,111,521	45,663,900
1983	73,829,928	58,232,847
TOTALS	328,238,376	250,331,977

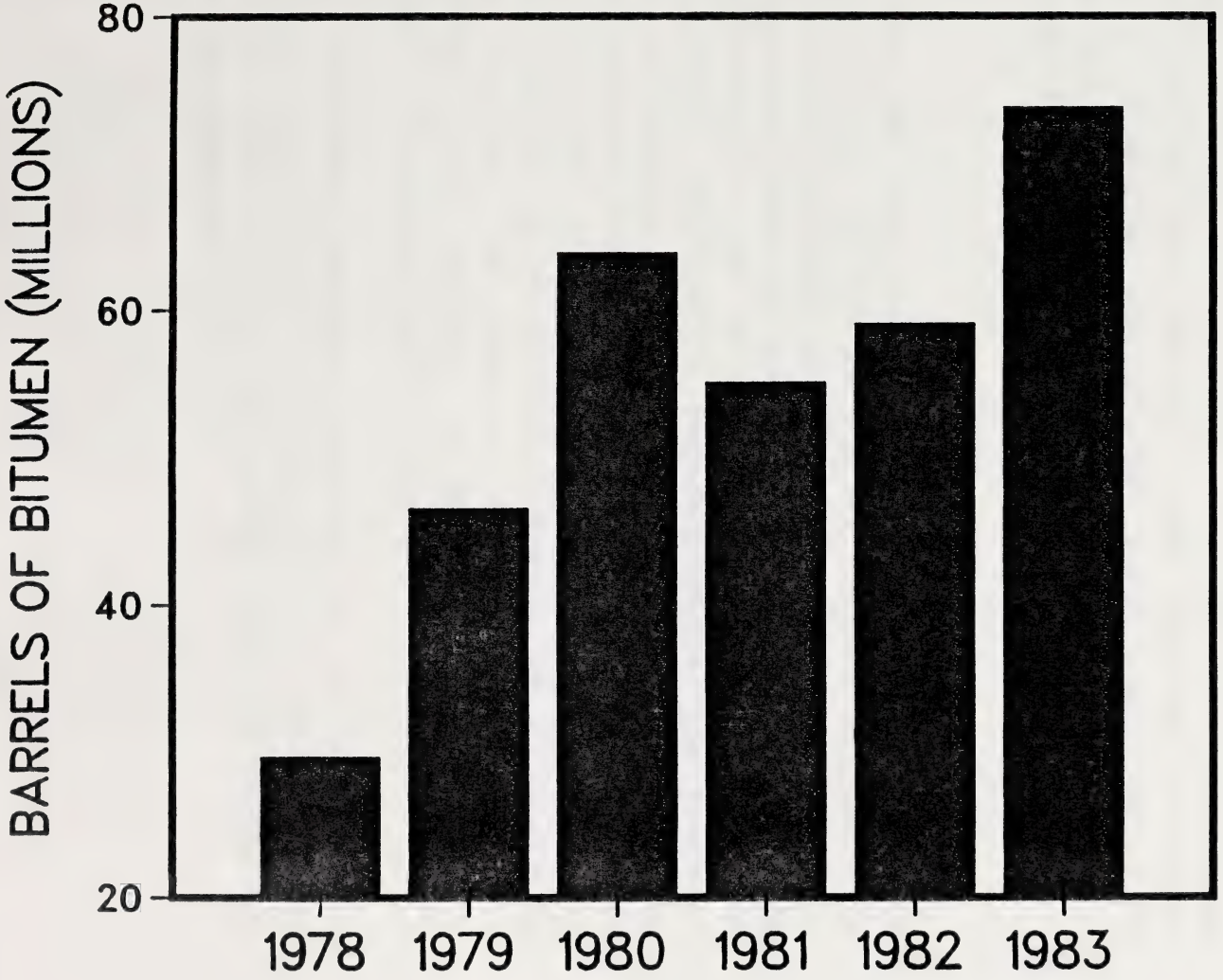
NOTES:

1. Total bitumen includes material recycled at Syncrude plant.

2. Includes distillate (i.e., not hydrotreated) produced at Suncor in 1978-79, 1981-83 and in 1983 at Syncrude. Also includes diesel fuel used at Suncor.

Source: Energy Resources Conservation Board.

FIGURE 1:ALBERTA OIL SANDS PRODUCTION,1978–83



SOURCE:ERCB

NUMBER OF CLAIMS AND CLAIM RATES

Claims

During the period 1978-83, 3,492 claims in the oil sands industry were reported to and accepted by the Workers' Compensation Board (WCB). Of these claims, 840 were lost time claims. The estimated percentage of claims which involve lost time in the oil sands industry is much lower than the average for all industries together (15% versus about 40%). The proportion of lost time claims is based only on 1978-81 data as medical aid data are incomplete for 1982-83. (See Table A1).

Rates

The lost time claim rate for the oil sands industry remained fairly low over the six year period, averaging about 2.2 claims per 100 man-years worked. (See Table 3). However, the lost time claim rate steadily increased from 1.9 claims per 100 man-years worked in 1980 to 3.6 in 1983. This was substantially lower than the average provincial lost time claim rate (7.5) and the lost time claim rates for the oil and gas industries and surface coal mining. From 1978 to 1980, the lost time claim rate of mining, oil and gas industries was three times that of the oil sands industry. The relatively low number of lost time claims in the oil sands industry is reflected in the relatively low WCB assessment rate of $1.60 per $100 of assessable payroll in 1983.

The estimated man-years worked in the oil sands industry fluctuated considerably over these six years. Man-years worked peaked at 8,558 in 1980, a 67% increase from 5,133 man-years in 1978. (See Table 3).

The lost time claim rate per million barrels of bitumen produced also fluctuated during the six year period, ranging from a low of 1.8 claims in 1980 to a high of 3.1 claims in 1981. During this period annual production of synthetic crude oil more than doubled. (See Table 4).

The number of claims and claim rates in the oil sands industry should be interpreted with caution as claims charged to subcontractors working on oil sands sites have not been included in this study.

Both of the major oil sands plants have a major sub-contractor for maintenance work. The work of the sub-contractor includes maintenance work in the extraction, upgrading and mining areas in addition to such work as on-site construction (ditches, sewers, digging, etc.). In addition, the major sub-contractor may also hire other sub-contractors for specific projects such as pipelaying. The size of the workforce of sub-contrators is substantial and fluctuates according to projects being undertaken. At times, it may be as large as the regular staff of the principal oil sands companies. Since the work of sub-contractors is generally more hazardous than the regular operations of the oil sands industry, the lost time claim rates presented in this report may be underestimates.

FIGURE 2:LOST TIME CLAIM RATES OIL SANDS INDUSTRY,1978–83

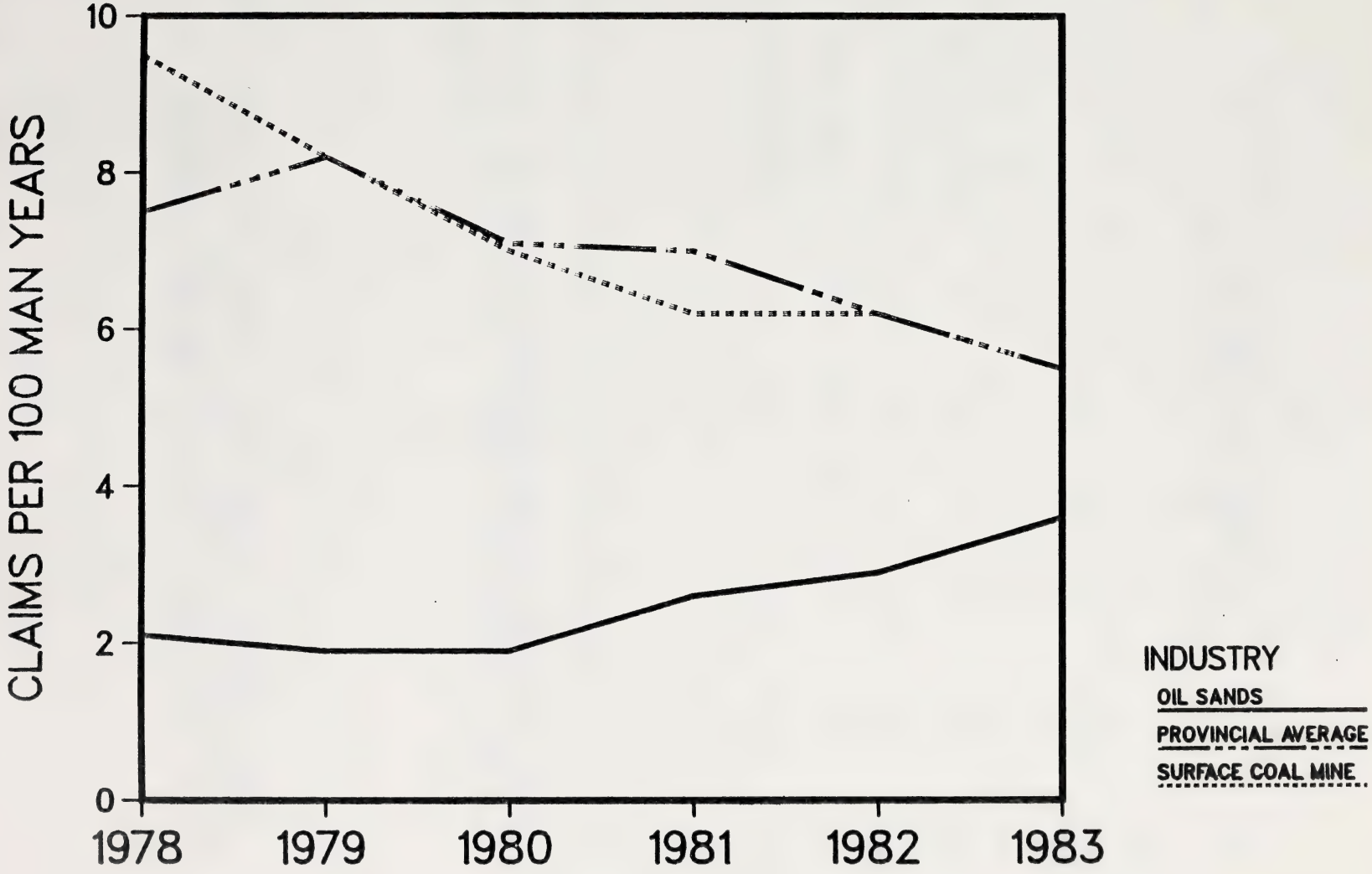


TABLE 3

ESTIMATED CLAIM RATES* (PER 100 MAN-YEARS WORKED)
AND MAN-YEARS WORKED IN
THE OIL SANDS INDUSTRY, ALBERTA,
1978 - 1983

	1978	1979	1980	1981	1982**	1983**
Estimated Man-Years	5,133	5,914	8,558	6,947	7,649	4,676
Lost Time Claim Rate	2.1	1.9	1.9	2.6	2.9	3.6
Number of Lost Time Claims	110	116	169	183	227	169
Total Claim Rate	12.3	12.4	13.5	10.5	-	-
Mining, Oil & Gas Lost Time Claim Rate	7.0	7.0	6.3	4.6	3.9	3.9

* Does not include claims or man-years of subcontractors.

**After 1981, complete information on medical aid claims is not available due to changes in reporting requirements. Hence, a comparable estimate of total claims rate cannot be made for 1982 and 1983.

SOURCE: Occupational Health and Safety Division Report WHOH6102, 1978 - 1983. Number of man-years is estimated from wage and payroll data reported by employers to the WCB.

FIGURE 3:LOST TIME CLAIM RATES PER MILLION BARRELS OF BITUMEN,1978–83

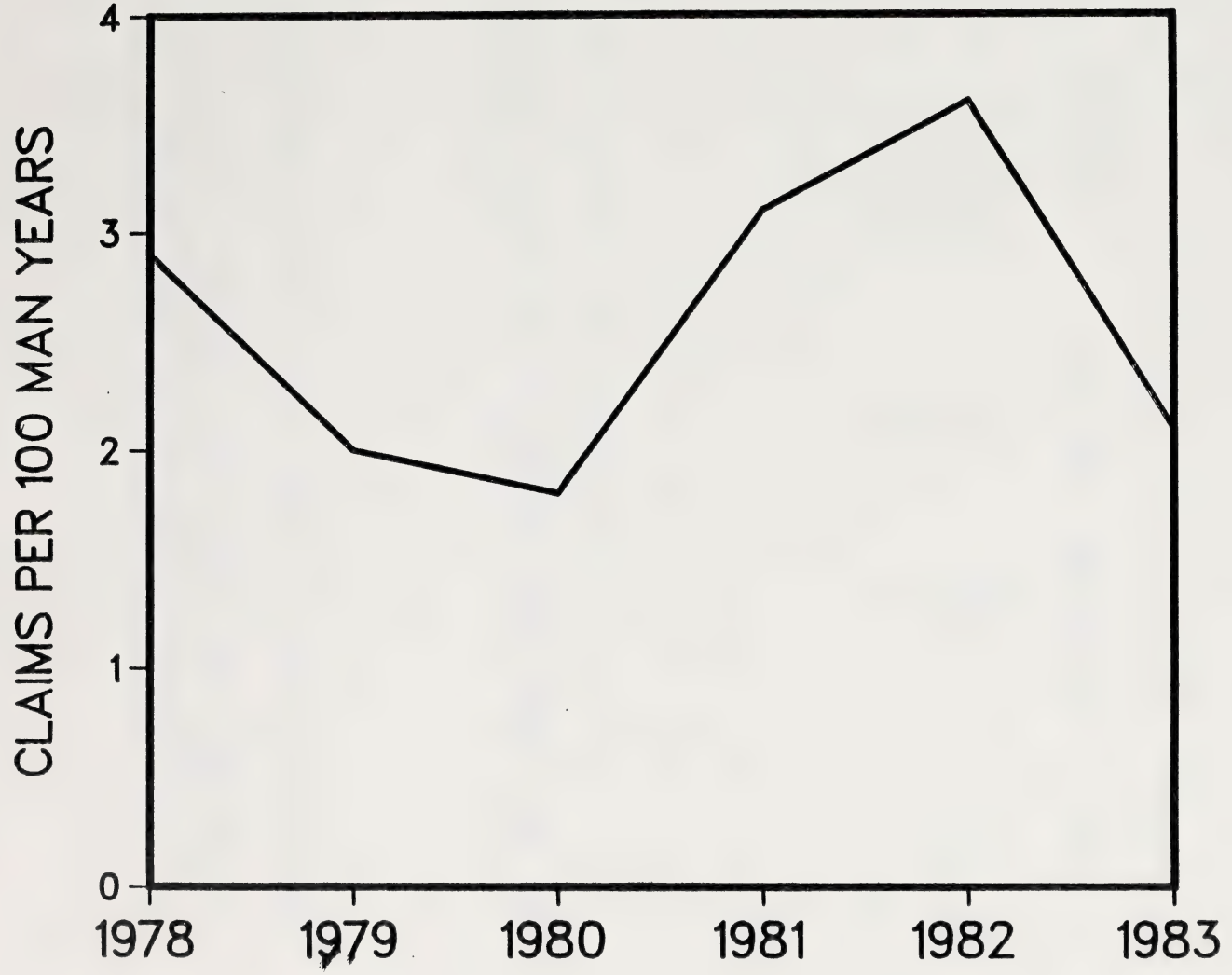


TABLE 4

CLAIM RATES PER ONE MILLION BARRELS OF BITUMEN PRODUCED
ALBERTA, 1978 - 1983

YEAR	BARRELS OF BITUMEN[1]	CLAIM RATES/10^6 BARRELS OF BITUMEN		
		LOST TIME	MEDICAL AID[2]	TOTAL
1978	29,630,227	2.9	20.3	23.3
1979	46,625,414	2.0	14.0	16.0
1980	63,910,400	1.8	11.8	13.6
1981	55,130,886	3.1	11.7	14.7
1982	59,111,521	3.6	-	-
1983	73,829,928	2.1	-	-
TOTAL	328,238,376	2.6		

NOTES:

1. Conversion factor of: $1m^3$ = 6.29 barrels.

2. Complete information on medical aid claims was not available after 1981 due to changes in reporting requirements.

SOURCES:

1. Production figures from the Energy Resources Conservation Board, Alberta.

2. Claim rates calculated using data from the Workers' Compensation Board Statistical Master File Tapes, 1978 - 1983. Totals include all new claims reported to the WCB and finalized by March 31 of the following year.

CHARACTERISTICS OF LOST TIME CLAIMS

This section describes the characteristics of the 840 lost time injuries and illnesses reported to the WCB from 1978 to 1983 inclusive.* They are classified by accident type, source of injury, part of body injured, claimant occupation, nature of injury and age at time of the accident. Detailed data on the characteristics of these lost time claims can be found in Appendix A (Tables A2-A9).

Occupational diseases accounted for 8.8% of the lost time claims, a higher proportion than is generally found for lost time claims across all industries. An occupational disease is defined according to the American National Standard Institute's (Z16.2) definition. See Table A8 for a list of the categories classified as occupational diseases.

Accident Type

The *accident type* identifies the event that directly resulted in the injury. *Overexertion* accounted for the largest group of claims (21%) followed by *bodily reaction* with 17% and *struck by* with 13% of the lost time claims.

Source of Injury

The *source of injury* identifies the object, substance exposure or bodily motion which directly produced the injury or illness. *Working surfaces* and *bodily motion* each accounted for 17% of the lost time claims followed by 15% for *metal items*.

* This total differs from the total of 974 lost time claims in Table 3 because of slightly different selection criteria.

Nature of Injury

The *nature of injury* identifies the injury or illness in terms of its physical characteristics. *Sprains and strains* accounted for almost half (48%) of the lost time claims. This category was followed by *contusion, crushing and bruising* which accounted for 16% of the claims.

Part of Body

The *part of body* identifies the part of the injured person's body directly affected by the injury or illness. The *back* was the most commonly injured body part accounting for 30% of the lost time claims. This was followed by 11% for *legs* and 10% for *ankles and feet*.

Most of these back claims (94%) involved *strains and sprains*. The most common accident types involving back claims were *bodily reaction* and *overexertion* which together accounted for 79% of the back claims. The most common sources of injury for back claims were *bodily motion* and *working surfaces* which together accounted for 41% of the back claims.

Occupation

Mechanics (21%), construction (20%) and mining (19%), occupations accounted for the largest percentage of lost time claims. *Welding and flame cutting* occupations accounted for approximately 9% of the lost time claims. More specific occupations of claimants are detailed in Table A5.

Age at Time of Accident

Workers aged 25 to 34 years accounted for the largest percentage of the lost time claims (42%) followed by workers aged 35 to 44 years with 25% of the lost time claims. The youngest workers, aged 15 - 24 years, accounted for 21% of the lost time claims.

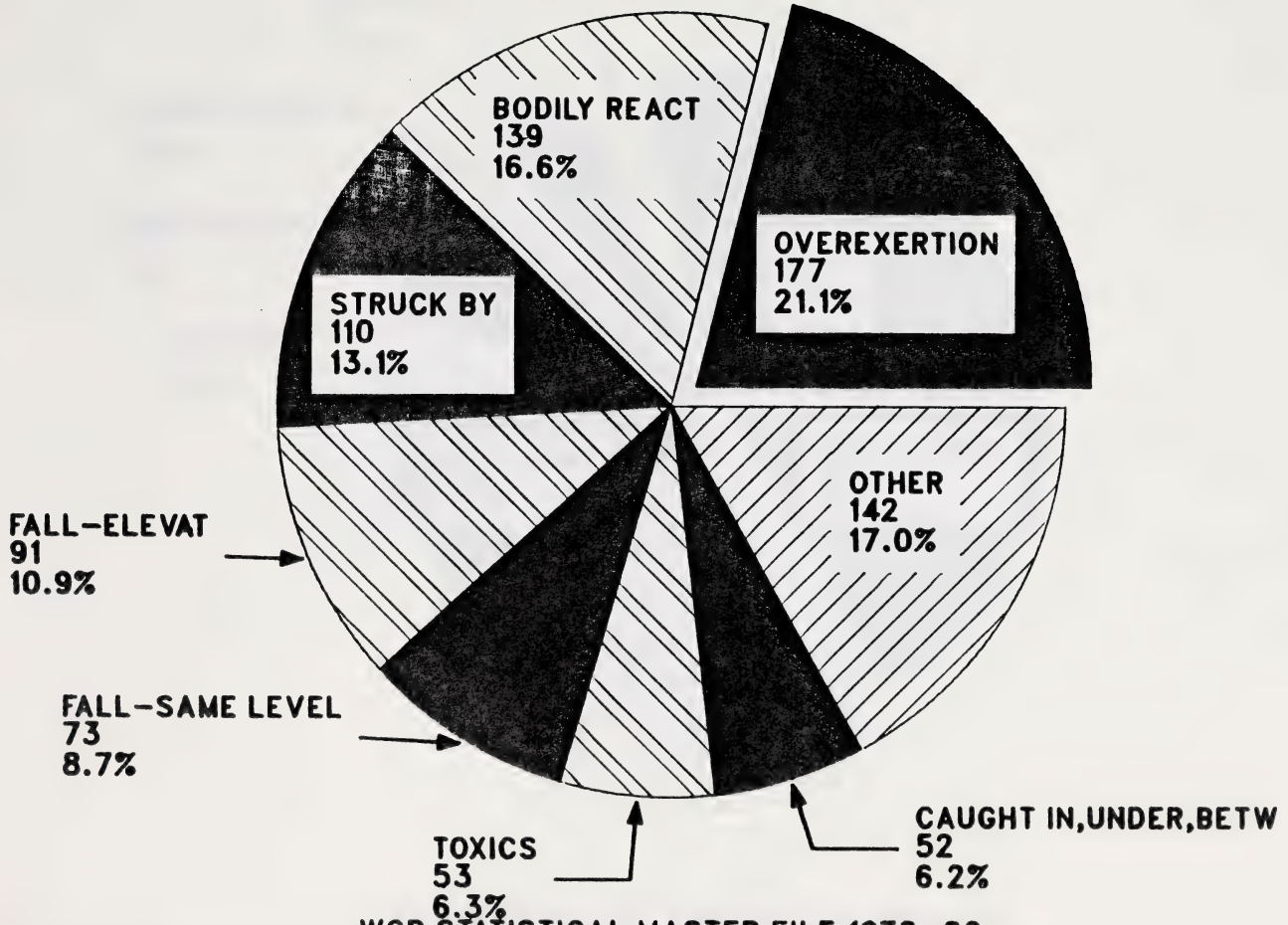
Length of Time Employed with this Employer

The majority of lost time claimants were employed with their employer one year or more before the accident or illness occurred.

Occupational Diseases

Occupational disease claims (see table A8, page 56 for a list of claims included in this category) accounted for 8.8% of the lost time claims. Of the 74 disease claims, the largest proportion (just over one quarter), were *burns due to caustic chemicals* followed by *systemic poisoning to the respiratory system* and *systemic poisoning (not elsewhere classified)*. These claims are further discussed in the section titled *"Health Implications of Oil Sands."*

FIGURE 4:LOST TIME CLAIMS IN OIL SANDS INDUSTRY BY ACCIDENT TYPE,1978–83



WCB STATISTICAL MASTER FILE,1978–82

FIGURE 5:LOST TIME CLAIMS IN OIL SANDS INDUSTRY BY SOURCE OF INJURY 1978–83

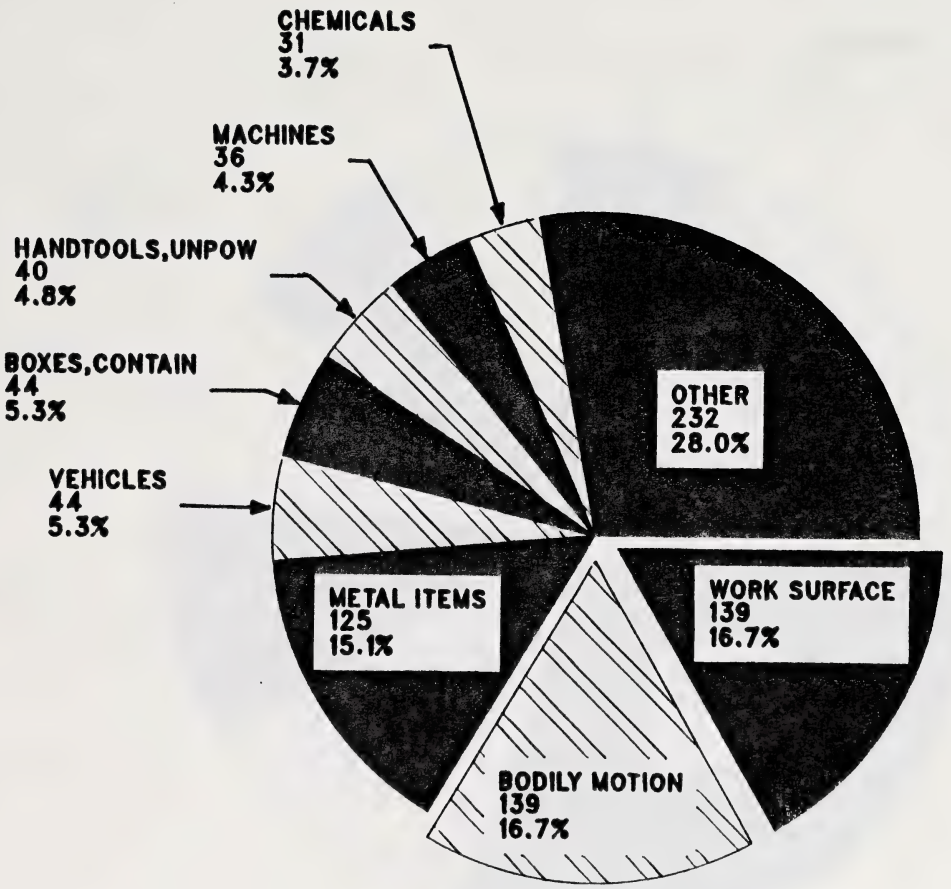
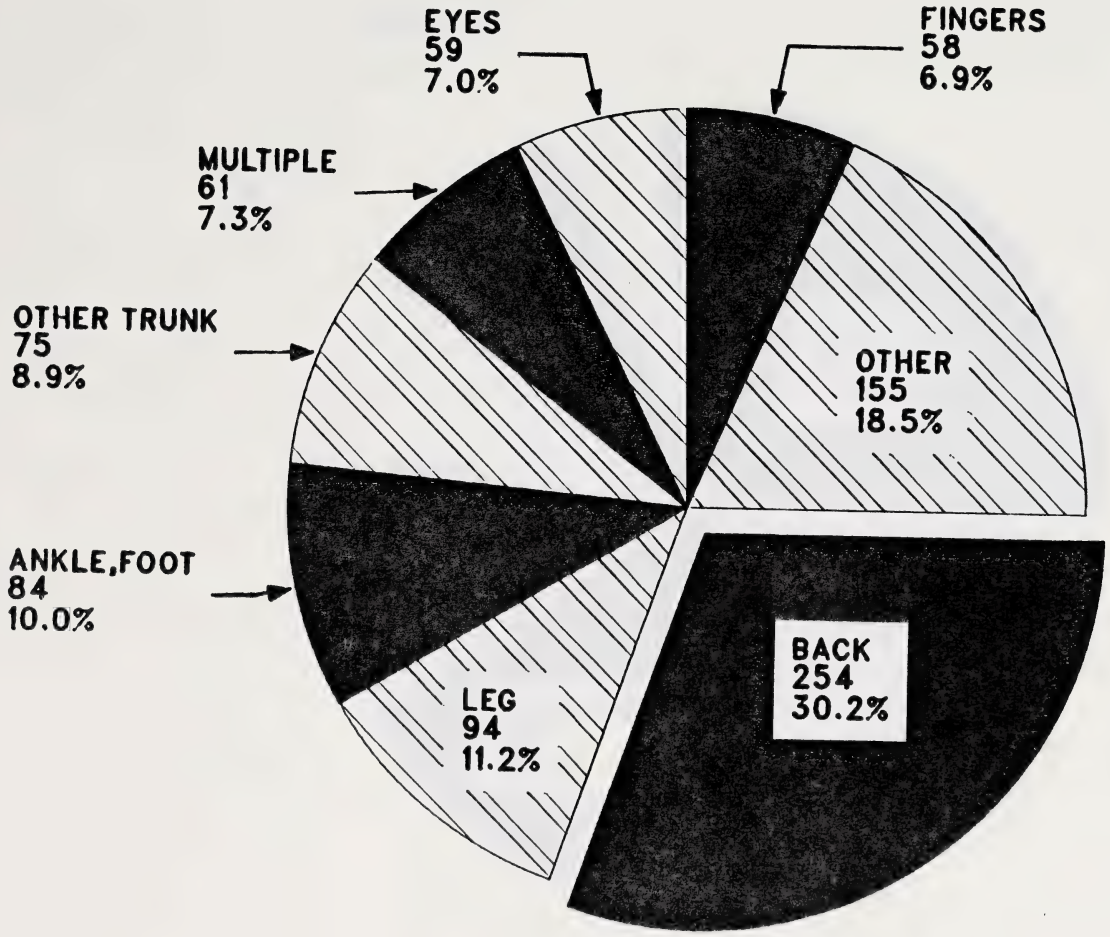
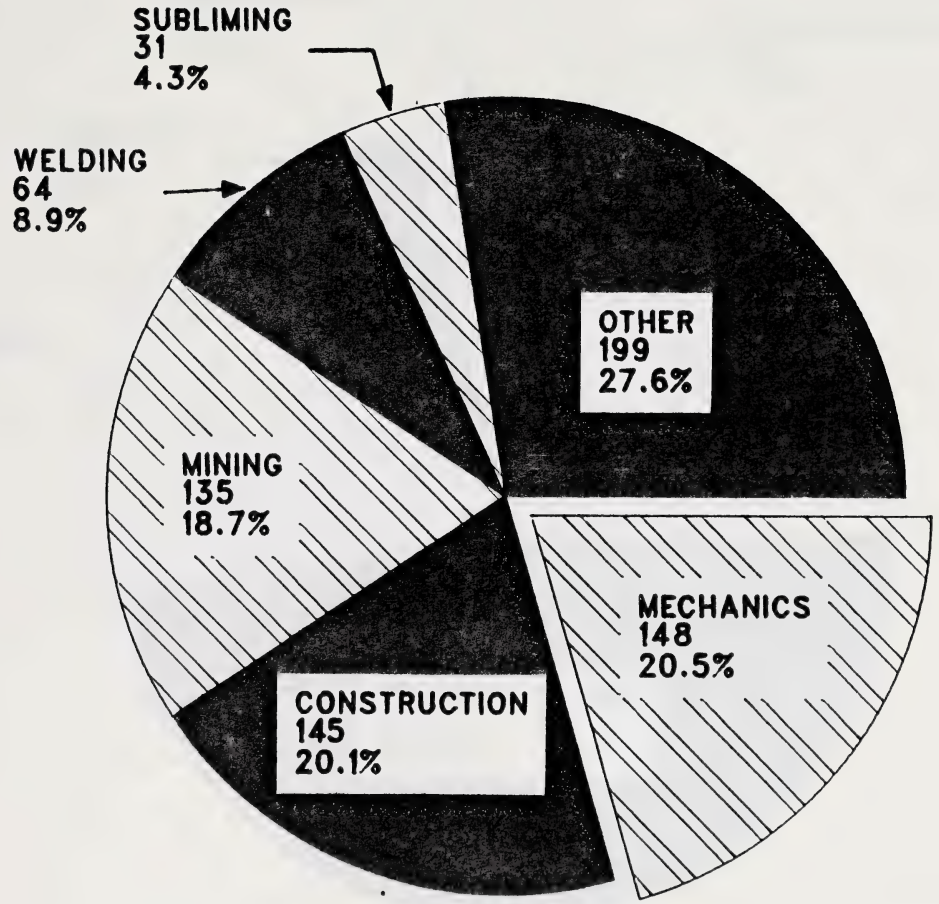


FIGURE 6:LOST TIME CLAIMS IN OIL SANDS INDUSTRY BY PART OF BODY INJURED 1978–83



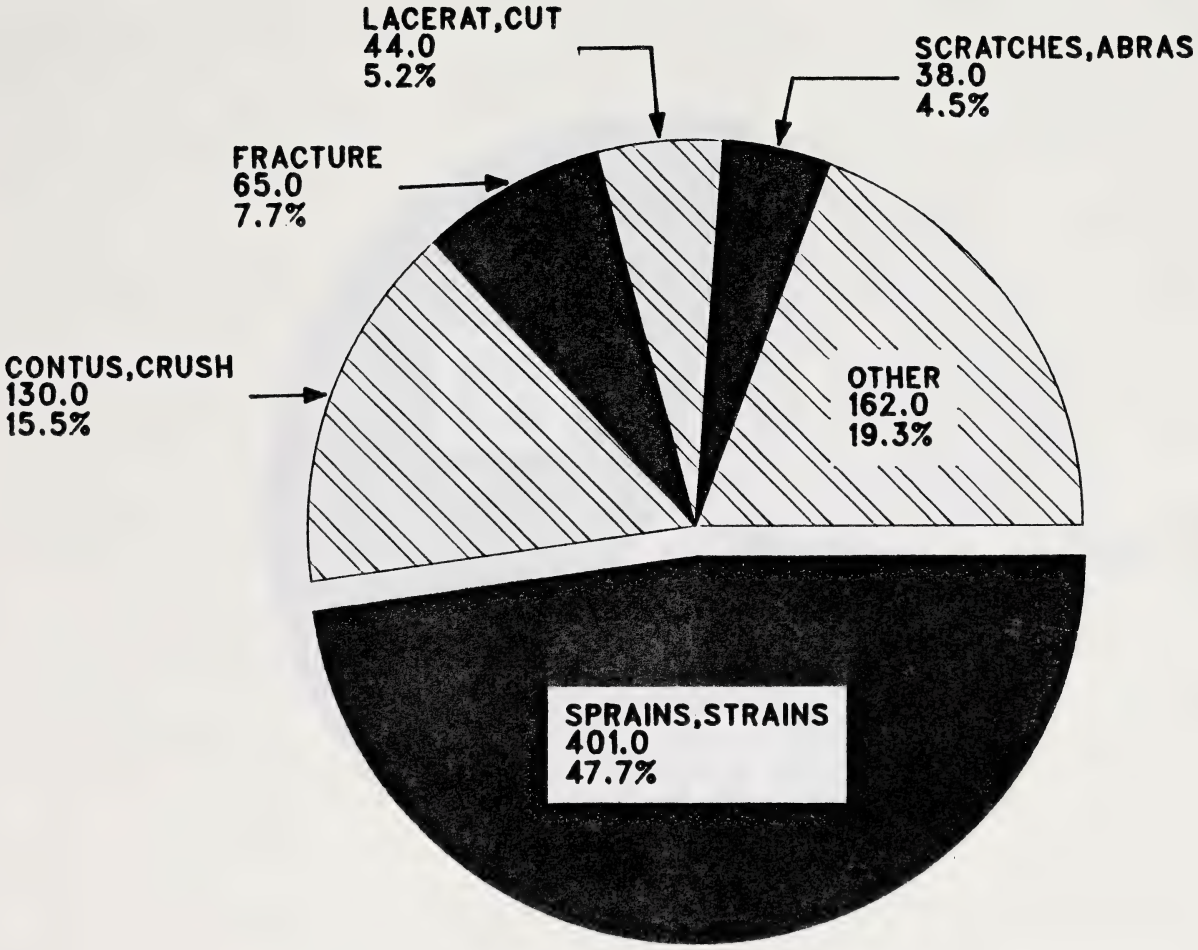
WCB STATISTICAL MASTER FILE,1978–83

FIGURE 7:LOST TIME CLAIMS IN OIL SANDS INDUSTRY BY OCCUPATION OF CLAIMANT, 1978–83



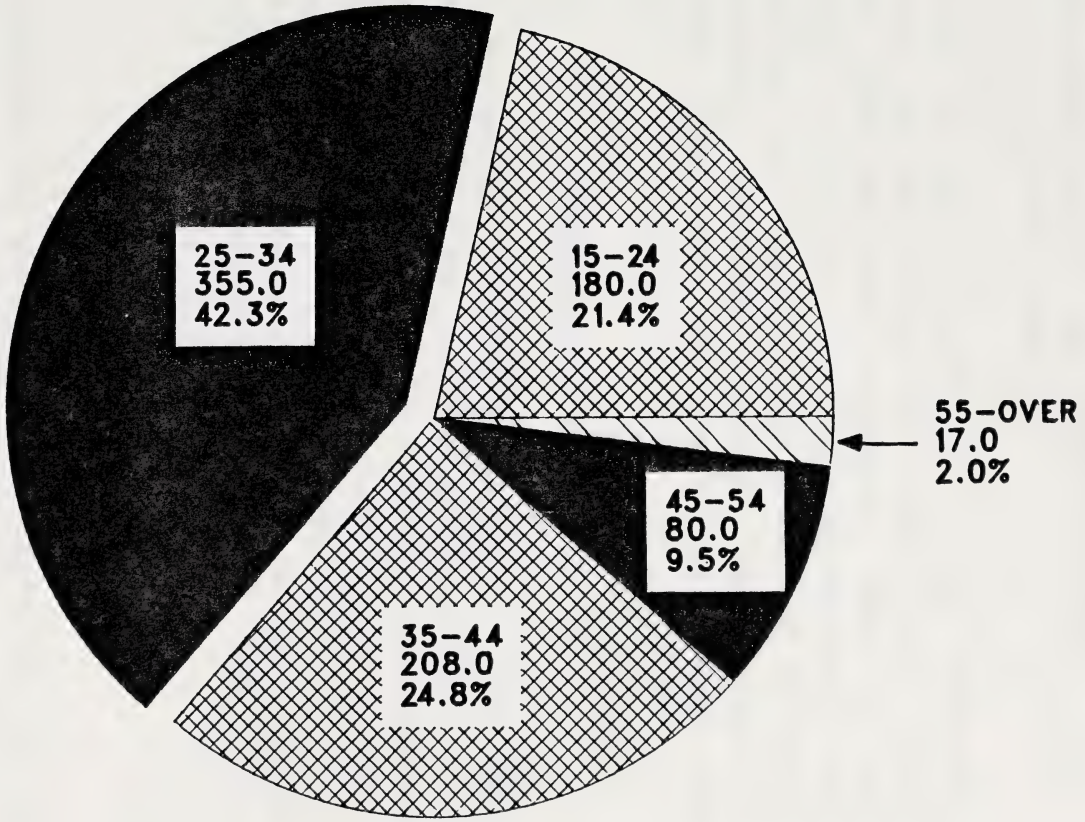
WCB STATISTICAL MASTER FILE, 1978–83

FIGURE 8:LOST TIME CLAIMS IN OIL SANDS INDUSTRY BY NATURE OF INJURY, 1978–83



WCB STATISTICAL MASTER FILE,1978–83

FIGURE 9:LOST TIME CLAIMS IN OIL SANDS INDUSTRY BY AGE AT TIME OF ACCIDENT, 1978–83



WCB STATISTICAL MASTER FILE, 1978–83

FATALITIES INVESTIGATED BY THE
OCCUPATIONAL HEALTH AND SAFETY DIVISION
ALBERTA OIL SANDS INDUSTRY AND RELATED INDUSTRIES,
1976 - 1983

Ten fatalities in the oil sands and related industries were investigated by the Occupational Health and Safety Division between 1976 and 1983 inclusive. Three of the fatalities occurred to employees classified as working in the oil sands industry and seven occurred on the sites of oil sands operations involving companies carrying out contracted operations. Recent fatalities have involved maintenance and repair activities.

Unsafe Acts*

Failure to secure or warn was the category of unsafe acts identified in three fatalities. These unsafe acts basically involved starting or stopping equipment, vehicles, machines and other devices without proper warning to other workers. Such acts also include failure to secure or lock vehicles, switches, valves and equipment against unexpected movement, and failure to place adequate warning signs, signals, tags, etc. (See Table 6)

Unsafe Conditions*

Hazardous layout was the unsafe condition identified in six fatalities followed by *improperly guarded* for four fatalities.

*Note: Several unsafe acts , conditions or indirect causes may have been involved in a single fatality.

Indirect Cause*

The most common indirect causes identified were *unsafe job procedures* and *worker's lack of experience*, each being identified in five fatalities.

Age and Experience

Eight of the 10 fatalities were workers under age 35 and five of these were under 25 years old. Four of these workers had less than one year's experience in the industry . (See Table 7).

Regulations Cited

A total of 23 regulations were cited for the ten fatalities investigated. Thirteen citations cited involved the general accident prevention regulation which states "Every employer shall adopt and use methods and procedures which are adequate to render his employment or place of employment safe and shall do everything necessary to protect the life, health, and safety of his employees". Regulation 267 70 020 (re: employer's responsibility to ensure a safe place of employment) was cited four times.

*Note: Several unsafe acts , conditions or indirect causes may have been involved in a single fatality.

TABLE 5

FATALITIES INVESTIGATED BY THE
OCCUPATIONAL HEALTH AND SAFETY DIVISION:
ALBERTA OIL SANDS INDUSTRY, AND RELATED INDUSTRIES,
1976 - 1983

OIL SANDS INDUSTRY

1. YEAR: 1979 AGE: 23
OCCUPATION: Mines Equipment Operator EXPERIENCE: 1-3 mo.
INDUSTRY: Mining & Processing of Bituminous Sand

DESCRIPTION: A D-9 Caterpillar tractor, operated by the deceased, was cleaning out a blasted shale ditch on the bottom bench. During this operation, the dozer overturned, pinning the victim between the ROPS canopy and the floor of the ditch. The machine had half its seat belt missing.

2. YEAR: 1981 AGE: 22
OCCUPATION: Labourer EXPERIENCE: 6mo.-1yr.
INDUSTRY: Mining & Processing of Bituminous Sand

DESCRIPTION: The workers were working in the area of a pipeline under pressure. While working on some pipe approximately 30 feet away from the pressurized line, the workers were struck by this pressurized pipeline which had disconnected while under pressure. The pipe, on disconnecting, lashed around vertically and horizontally, striking one worker in the back of the head. One worker was killed and the other suffered injuries to his legs and one arm.

3. YEAR: 1982 AGE: 32
OCCUPATION: Process Operator EXPERIENCE: 1-5 yrs.
INDUSTRY: Mining & Processing of Bituminous Sand

DESCRIPTION: Four workers were involved in sweeping oil from a heater in the process area. Two workers had proceeded to the top platform (catwalk) to close two valves on the snuffing steam line and the charge line. The valves were opened and a vapor cloud was noticed around the worker on the platform who was now indicating he wished the valves closed. There was an explosion and fire engulfed the worker on the platform.

FATALITIES OCCURRING ON OIL SANDS SITES*

4. YEAR: 1976 AGE: 55
OCCUPATION: Electrician EXPERIENCE: 10 or more yrs.
INDUSTRY: Construction of Bldgs.& Plants

DESCRIPTION: The worker had descended from the work platform to the bus bar. From this point he crawled through the cross braces on the metal scaffold and attempted to climb down the scaffold adjacent to the ladder section. He apparently lost his footing or let go with his hand, causing him to lose his balance. He fell backwards approximately 6 feet where his head hit a suspended switch gear. After impact, he fell a further 5 feet to the concrete floor.

5. YEAR: 1977 AGE: 29
OCCUPATION: Iron Worker EXPERIENCE: 5-10 yrs.
INDUSTRY: Construction of Bldgs. & Plants

DESCRIPTION: The worker was crawling along a purlin 31 feet in the air to assist his partner. When he reached the choker, it is not clear whether he attempted to crawl or walk the rest of the way. It is assumed that his weight on the bottom flange of the purlin caused it to twist. The twisting action made the worker lose his balance and fall 31 feet to the ground.

6. YEAR: 1980 AGE: 23
OCCUPATION: Welder EXPERIENCE: 3 yrs.
INDUSTRY: Erection, demolition of storage tanks

DESCRIPTION: The worker had been contracted to remove roof plates on a 500,000 gallon storage tank in order to replace and repair loose or fallen roof supports. The worker was gouging out tap patches in certain sections of roof panels for their removal. Although he had been instructed to leave 6" welds in place at various intervals, he had made a full cut which caused the plate to bend downward. It is assumed that the deceased was positioned on this plate, adding further weight. A radial member directly under this cut had been dislodged at some time and was lying at the bottom of the tank. In the absence of this rafter, the plate continued to bend causing the worker to fall 48 feet to the tank bottom.

*Includes fatalities which occurred on the sites of oil sands operations involving companies carrying out related operations in industries other than oil sands.

7. YEAR: 1981 (DOUBLE FATALITY) AGE: 24
OCCUPATION: Technician EXPERIENCE: 1-5 yrs.
(stress relieving)
INDUSTRY: Heat Treating of Metal

8. OCCUPATION: Labourer AGE: 18
INDUSTRY: Heat Treating of Metal EXPERIENCE: 6-30 days

DESCRIPTION: The two workers were involved in the replacement of a faulty pack in the stress relieving operation on the work platform on the top of a guard reactor in the process area plant. The reactor was undergoing a constant nitrogen purge. The worker dropped his crimping tool inside the reactor. When he entered the reactor to retrieve it, he immediately fell over into the top of the reactor bed. A fellow worker entered the reactor to assist him with same result. Both were asphyxiated by the oxygen deficient atmosphere inside the reactor.

9. YEAR: 1981 AGE: 26
OCCUPATION: Driller helper EXPERIENCE: 6-12 mo.
INDUSTRY: Shothole Drilling

DESCRIPTION: A driller and a helper were working as a team on a seismic drilling rig at a tar island dyke. Their task was to drill and core a sample for a foundation analysis of the dike foundation stability. They were in the process of raising a drill stem to attach it to the drill pipe already in the hole. The drill stem being raised was at approximately a 45 degree angle in the lift when it came loose from the hoisting plug and fell, striking the helper on the head causing fatal injuries.

10. YEAR: 1981 AGE: 47
OCCUPATION: Welder - Iron Worker EXPERIENCE: 5-10 yrs.
INDUSTRY: Maintenance of Plants

DESCRIPTION: Witnesses' statements confirm that the worker was welding on a ladder between two walkways on a bucketwheel which was being upgraded for re-entry into use in the mining area. It is assumed that the 5 gallon unapproved storage container of toluene, a flammable liquid, spilled on the worker. It is assumed that the welder was either striking an arc at the time of the spill or when the toluene struck him, he ground the welding electrode against the grounded member of the bucketwheel, causing ignition.

SOURCE: Occupational Health & Safety Division Fatality Investigation Data Base, 1976-1983.

TABLE 6

FATALITIES INVESTIGATED BY OHSD:
OIL SANDS AND RELATED INDUSTRIES BY ACCIDENT CAUSES,
1976 - 1983

Unsafe Acts Identified	#	%
Failure to secure, warn	3	23.1
Using unsafe equipment	2	15.4
Unsafe position	2	15.4
Working on moving equipment	2	15.4
Working at unsafe speed	1	7.7
Unsafe loading, placing	1	7.7
No unsafe act identified	2	15.4
TOTAL	13*	100.0
Unsafe Conditions Identified		
Hazardous layout	6	40.0
Improperly guarded	4	26.7
Defective tools and equipment	2	13.3
No unsafe condition	3	20.0
TOTAL	15*	100.0
Indirect Causes Identified		
Unsafe job procedures	5	33.3
Lack of experience of worker	5	33.3
Worker's mental or physical limitation	2	13.3
Management's disregard of safety procedures	1	6.7
Other	1	6.7
No indirect cause	1	6.7
TOTAL	15*	100.0

*Total adds to more than 10 as multiple unsafe acts, conditions and indirect causes can be coded for each fatality.

SOURCE: Occupational Health and Safety Division Fatality Investigation Data Base, 1976 - 1983.

TABLE 7

FATALITIES INVESTIGATED BY OHSD:
OIL SANDS AND RELATED INDUSTRIES BY EXPERIENCE AND
AGE OF CLAIMANT, 1976 - 1983

Experience	#	%
6 - 30 days	1	10.0
1 month - 3 months	1	10.0
6 months - 1 year	2	20.0
1 year - 5 years	3	30.0
5 years - 10 years	2	20.0
10 years or more	1	10.0
TOTAL	10	100.0

Age	#	%
15 - 24 years	5	50.0
25 - 34 years	3	30.0
45 - 54 years	1	10.0
55 - 64 years	1	10.0
TOTAL	10	100.0

SOURCE: Occupational Health and Safety Division Fatality Investigation Data Base, 1976 - 1983.

Occupational Disease Claims

The 74 occupational disease claims in the Alberta oil sands industry accounted for a higher percentage of lost time claims than is generally found in other industries (8.8 % versus approximately 5% for other industries). Since approximately 85% of the total claims in the oil sands industry during the period 1978-81 were medical aid claims, it is estimated that there may have been approximately six times as many medical aid as lost time occupational disease claims for the period 1978 to 1983.[5] (See Table A8 for the classifications defined by the WCB as disease claims).

Of the lost time disease claims, 19 (25.7%) involved *burns due to caustic chemicals or fumes. Systemic poisoning affecting the respiratory system* accounted for 17 (23%) claims with a further 7 (9.5%) claims involving *systemic poisoning not elsewhere classified.*

The 68 lost time occupational disease WCB claim reports occurring from 1978 to 1982 were examined in detail to obtain more information on the sources of injury involved. The individual paper files were examined because they contained more detail on the names of the chemicals and gases involved than the computerized WCB data base. The following details the content of these files. One-half of these claims involved various chemicals or gases as the source of injury. They

[5]Complete information for medical aid claims is not available in 1982 and 1983 due to changes in WCB reporting requirements. From 1978 to 1981, there were 264 medical aid disease claims versus 39 lost time disease claims.

included *cleaning solvents* (5), *hydrogen sulfide* (5), *caustic soda* (4) and *sulfuric acid* (3). Gases and fumes (8) included *naphtha fumes, chlorine gas, ammonia* and *fumes from oil sands bins.* Other chemicals (5) included *potassium carbonate* and *ammonium polysulfide.* Seven claims involved *welding flashes.*

Toxicity of Oil Sands & Related Products

There is very little information in the literature on the specific health hazards of exposure to oil sands and related products.[6] However, a recent major study contracted by Syncrude Canada to the Research and Environmental Health Division of the Exxon Corporation assessed the potential toxic hazards associated with the production of liquid hydrocarbons from the Athabasca oil sands.[7] The purpose of this study was to assist Syncrude in setting occupational exposure standards for these liquid hydrocarbons.

The eight hydrocarbons selected included tar sands diluted in toluene, bitumen, bitumen diluted in naphtha, untreated naphtha, light gas-oil, heavy gas-oil, gas-oil blend and synthetic crude oil. These materials were tested either because of potential human contact or because biological activity was predicted from results of studies of similar petroleum-derived products. It should be pointed out that with the use of certain personal protective equipment, the effects of exposure to some oil sands' products can be minimized. Two types of studies were conducted: acute studies and chronic dermal (skin) carcinogenic studies.

Acute Studies

The acute studies involved the following four studies: acute oral, acute dermal, acute ocular irritation and acute inhalation. These studies evaluated the acute toxic effects of

[6]Literature does exist on the hazards of products from the conventional crude oil industry. It is not certain to what extent the findings can be generalized to the oil sands industry.

[7]Richard H. McKee. Evaluation of the Toxic Potential of Tar Sands - Derived Liquids, Research and Environmental Health Division of Exxon Corporation, 1984.

bitumen dissolved in naphtha, untreated naphtha and synthetic crude oil on rats, mice and rabbits.

Acute Oral - None of the test materials induced mortality in the acute oral studies even at the very large dose of 5gm/kg limit.

Acute Dermal - All three materials produced slight dermal irritation in rabbits. Most of the irritation was resolved in the 14 day observation period and there was no evidence of severe dermal injury or death of tissue.

Acute Ocular - Ocular irritation was judged slight in all studies of the rabbits. All evidence of ocular irritation was resolved within the post-treatment period (between 4 and 7 days).

Acute Inhalation - Bitumen plus naphtha did not induce any mortalities in a six hour inhalation study at a concentration of 1.5 mg/l, the maximum attainable concentration. However, many of the animals showed signs of ocular irritation and laboured breathing during exposure. The lung to body weight ratio of the exposed male rats was significantly reduced. No other significant effects were noted.

However, exposure to a liquid aerosol/vapor of untreated naphtha at a concentration of 10.6 mg/l for six hours caused death in the animals (10/10 mice and 2/10 rats). Evidence of ocular irritation, laboured breathing, reduced activity and convulsions were noted during the exposure period. Body weights of surviving rats were significantly reduced compared to controls during the first post-exposure week. The lung to body weight ratio in male rats and the liver to body weight ratio in females were both significantly increased.

Inhalation exposure to 4.0 mg/l of an aerosol of synthetic crude resulted in deaths (5/10) only to the mice - no rats died. Exposed animals exhibited symptoms similar to the naphtha group. In addition, almost complete hair loss occurred in the surviving mice.

Carcinogenesis Studies

Repeated treatment with tar sands did not produce any skin tumors. Bitumen and untreated naphtha produced low tumor yields. Light gas oil and synthetic crude oil produced tumors in 30 % of the sample. On the other hand, heavy gas oil (not hydrotreated) and gas oil blends produced very high tumor yields of 100%. Survival was also significantly reduced in these groups because of the rapid development of skin cancers.

Conclusions

The acute studies indicated that the Syncrude materials tested represented low hazards to health unless inhaled in extremely high concentrations. The author of the study reported that the acute inhalation studies were conducted at exposure levels well in excess of those encountered under normal working conditions. The data from the acute toxicity studies were consistent with results of studies of petroleum derived materials. Toxicity studies of conventional crude oil products published by the American Petroleum Association provide additional information on this topic. Analyses of the latter studies are beyond the scope of this paper.

The carcinogenesis studies showed that tar sands did not produce tumors. R.H. McKee concluded that minimal skin cancer risks were associated with bitumen (tumors in 2 animals) and untreated naphtha (tumors in 1 animal). The cracked liquids from several boiling ranges (i.e., raw gas-oil) indicated that

fractions containing materials which boil at high temperatures (greater than 316° C) were very active carcinogens. However, there is minimal exposure of workers to gas-oils during the production of oil sands products. The synthetic crude oil was a moderately active carcinogen similar in activity to conventional crude oil.

Toxicity of Diluent Naphtha

A major study done on Suncor's behalf by Cannon Laboratories, Inc. determined the 90-day inhalation toxicity effects of diluent naphtha. This study along with other studies on petroleum naphtha assisted the Oil Sands Group (O.S.G.) in co-operation with Alberta Occupational Health and Safety to set an 8-hour Occupational Exposure Level of 100 ppm(v/v) for the O.S.G. diluent naphtha.

Statistical analysis of parameters such as animal body weight, blood chemistry, hematology and pulmonary resistance and compliance showed no statistical difference between control and exposed animals. Gross pathology produced no evidence of compound-related organ changes or other signs of toxicity.

Histopathology was performed on sections of the trachea, lungs, livers and kidneys of animals from each experimental group. There was no increase in lesions reported in exposed vs control animals.

Animals which were retained for a 30-day post-exposure were examined again using the same parameters and the same general pattern was found.

(See Appendix C, page 60 for a description of health and safety programs at Syncrude and Suncor.)

Future Potential Hazards in the Vanadium Extraction Industry

The oil sands contain vanadium, a strategic heavy metal used to produce high-strength, low alloy carbon steel.

Two companies, Vadnore Enterprises and Renzy Mines, are interested in developing vanadium extraction plants in the oil sands area. The companies have potential plans to extract vanadium pentoxide from the fly ash of Suncor and Syncrude. According to Vadnore Enterprises, fly ash contains approximately 6,000 kilograms of recoverable vanadium pentoxide. The oil sands contain an estimated 3.6 million tons of vanadium pentoxide.[8] Walker, Luhning and Rashid (1976) state that the Athabasca oil sands deposit contains an amount equivalent to approximately 100 years supply at current world consumption rates in the mineable area alone.[9]

According to Mr. Middagh of Vadnore Enterprises,[10] the concentration of vanadium in the oil sands of Suncor and Syncrude is approximately 200 parts per million. During processing, vanadium pentoxide tends to get concentrated and is left in the fly ash after the coke is burned. According to Syncrude's Hygiene department, the concentration of vanadium pentoxide is 0.23% by weight of the fly ash. This concentration may decrease later because of processing changes. At Suncor, the concentration of vanadium pentoxide is 4-5% by weight of the fly ash.

[8]Edmonton Journal, May 1/84 and June 14/84.

[9]L.A. Walker, R.W. Luhning and K. Rashid, Potential for Recovering Vanadium from Athabasca Tar Sands, Great Canadian Oil Sands Ltd. Presented at the 26th Canadian Chemical Engineering Conference, 1976.

[10]Telephone conversation, November 7, 1985.

The economic feasibility of vanadium extraction depends on a number of factors such as the price structure and market for vanadium pentoxide.

The U.S. Occupational Safety and Health Administration (OSHA) reports that vanadium pentoxide dust can affect the body if it is inhaled or comes in contact with the eyes or skin. The short-term exposure effects include irritation of the eyes, nose, throat and respiratory tract, bronchitis with wheezing and chest pain. Long term exposure may cause more severe symptoms of the same nature. Repeated exposure may cause chronic bronchitis. A number of studies describe similar classic symptoms of workers exposed in vanadium plants, the alloy industry, power plants and utilities using vanadium rich oils. The eight hour occupational exposure limit (OEL) set by the Alberta Occupational Health and Safety Division for vanadium pentoxide dust is .05 milligrams per cubic meter of air. The 15 minute OEL is .15 milligrams per cubic meter of air. These time-weighted averages are based on limits set by the American Conference of Governmental Industrial Hygienists (ACGIH).

Although vanadium may not currently pose a health hazard in the oil sands industry, this situation could change if vanadium extraction plants are developed in the future.

FUTURE OIL SANDS DEVELOPMENT PROJECTS

Of the approximately 1.6 trillion barrels of bitumen in place in the four major oil sands deposits in Alberta, only about 33 billion barrels are shallow enough to be mined in the conventional manner. Suncor and Syncrude, even at full capacity, will only extract a small fraction of the mineable deposits. Even if enough new oil sands plants are developed to recover all the bitumen that can be mined, over 90 percent of the bitumen would still be in the ground. "Two hundred billion barrels of this are considered recoverable. Buried under 650 feet or more *of overburden*, this vast reserve can only be developed by those *in-situ** processes which separate the bitumen from the sand in place and thin it sufficiently to flow".[12] Research has shown that the most efficient way to overcome this problem is with the application of heat to the bitumen in the ground. Once the bitumen is made fluid enough, it is pumped to the surface.

A number of new oil sands projects are proposed to be developed in the next few years. Thus the manpower and the number of firms in the oil sands industry are likely to increase and the industry will become an even more important sector of the Alberta oil industry. As of August 1985, the following oil sands projects were proposed or scheduled to be developed in the next few years.[13]

*In place.

[12]Robert E. McRory, Oil Sands and Heavy Oils of Alberta, Alberta Energy and Natural Resources, 1982, p.49.

[13]Alberta Economic Development, Industry Development Branch, August 21, 1985

1. A $200 million *in-situ* steam injection oil sands project in Peace River will be developed by Shell Canada. Shell estimates four billion barrels of oil are potentially recoverable by the *in-situ* process. The project will be an expansion of the current pilot project that has been developed by Shell Canada and AOSTRA. The project involves drilling of about 200 wells and the expansion of steam generation and production facilities. Production will be 10,000 barrels of bitumen per day. If financial and regulatory requirements are met as planned, Shell will start building in early 1985 with completion in 1986. Construction will require a peak workforce of between 300 and 500, and 60 additional employees will operate the plant when it is on stream.

2. An *in-situ* recovery oil sands plant at the Cold Lake Clearwater oil sands deposit will be developed by Esso Resources Canada. The plant will be developed in eight phases with each two phase portion costing $200 million. Phase 1 and 2 have already started up and are producing 19,000 barrels per day. As of August, 1985, phases 3 and 4 are 50% complete and phases 5 and 6 are 10% complete. Phases 7 and 8 are also being planned. Upon completion of phase 6, it is expected that production will be 57,000 barrels per day.

3. An *in-situ* plant at Wolf Lake being developed by BP Canada has been upgraded to a two stage project with an output of 10,000 barrels per phase. Phase 1, at a cost of $120 million, is completed. Completion of phase 2, at a cost of $240 million, is scheduled for 1986-87.

4. The Alberta Oil Sands Technology and Research Authority (AOSTRA) is expected to invest $24 million in an underground oil sands research site to be located 60

kilometers northwest of Fort McMurray. AOSTRA plans to build a network of underground shafts and tunnels and then drill upward into the oil sands. Horizontal wells would then be drilled into the deposit and used to pump steam into the formation, releasing bitumen from the sands. A network of pipes from surface facilities would be used to feed the steam into the sands and recover the bitumen. AOSTRA is looking for industry to assume 50% funding of this research facility. However, AOSTRA intends to go ahead if industry does not invest in the project.[14]

5. A $4 billion Can-Star, NOVA and Petro-Canada oil sands plant with an output of 50,000 barrels per day is proposed for the Fort McMurray area. Presently, this project is in the environmental impact assessment stage.

6. A $1.5 billion Dome Petroleum *in-situ* oil sands plant at Primrose Lake is currently under application to the ERCB. The value of the first phase is $50 million.

7. Amoco is developing an *in-situ* thermal recovery oil sands plant at Elk Point. The $50 million first phase involves surface development. Long term expenditure could ultimately amount to $1.8 billion.

8. Murphy Oil is developing an *in-situ* oil sands plant at Lindbergh. Phase one involves an expenditure of $30 million with a possible larger future expenditure.

9. Suncor is applying in September, 1985 for a proposal to develop a $100 million *in-situ* oil sands plant at Burnt Lake.

[14]Edmonton Journal, July 6, 1984.

10. Syncrude's application to the ERCB for approval of the $1.2 billion expansion (only $450-$600 million of the expansion requires ERCB approval) states that between 1983 and 1987, the project will create 8,800 direct man-years and 13,200 indirect man-years in temporary work and 870 man years of direct and 1,305 man-years of indirect permanent work. Direct work refers to jobs created directly in the oil sands industry and indirect refers to jobs created in related industries supplying goods and services to the oil sands industry.

    In addition to this $1.2 billion expansion currently underway, Syncrude is also considering another $3 billion expansion. However, at this time, this proposal is only tentative.

11. Husky Oil is developing a $2.3 billion heavy oil production and upgrading facility at Lloydminster with a production capacity of 50,000 barrels per day. Steam will be used to stimulate the recovery of heavy oil. As of April, 1986 it is still uncertain if this project will go on stream as planned.

    The total value of these projects (excluding the tentative $3 billion Syncrude expansion and the Can-Star, Nova, Petro-Canada projects) is $4.7 billion.

CONCLUSION

The vast potential of the Alberta oil sands indicates that in the future, this resource will contribute a much larger share of the oil production in this province. Expansion of existing oil sands facilities (Syncrude and Suncor) or development of new facilities will require increased manpower in the construction and operational phases.

Overall, the claims experience of oil sands workers appears to be relatively low compared with the provincial average lost time claim rate. As noted, the claims data may underestimate the injury and illness experience of workers at oil sands sites since data were not available for sub-contracted workers. Occupational disease claims do, however, account for a somewhat higher proportion of all claims in the oil sands industry than the average for all industries together.

Very little research has examined the potential long term health effects associated with exposure to oil sands products. However, studies are available on the health effects of exposure to conventional crude oil products. Preliminary research such as that conducted by Exxon under contract to Syncrude Canada suggests the hazards are similar to those associated with conventional oil products. Since the exposure of oil sands workers to various oil sands products is minimal, the severity of these hazards may be low. Further research is needed on such topics as the carcinogenic and toxic effects of bitumen and its derived hydrocarbon products.

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4. L.A. Walker, R.W. Lahning and K. Rashid, "Potential for Recovering Vanadium from Athabasca Tar Sands", Great Canadian Oil Sands Ltd. Presented at the 26th Canadian Chemical Engineering Conference, 1976.

GLOSSARY

GLOSSARY

BITUMEN: A naturally-occurring viscous mixture of hydrocarbons that may contain sulphur compounds and that, in its naturally-occurring state, is not recoverable at a commercial rate through a well.

BUCKETWHEEL EXCAVATOR: A mining machine which utilizes toothed buckets mounted on the rim of a revolving wheel to scoop up oil sand and deposit it on a conveyor system.

BUCKETWHEEL RECLAIMER: Similar to bucketwheel excavator, used to recover mined oil sand from windrows and move it to a conveyor system.

COKE: The solid, black hydrocarbon left as a residue after the volatile hydrocarbons have been removed from bitumen by distillation.

COKERS: The vessels in which bitumen is "cracked" into its fractions.

CONVENTIONAL CRUDE OIL: Oil which can be recovered through a well at a commercial rate.

CONVERSION: The process of converting bitumen into synthetic crude oil; upgrading.

CRACKING: The process of breaking down the larger, heavier and more complex hydrocarbon molecules into simpler, lighter molecules. Separating crude oil or bitumen into fractions.

CRUDE OIL: Oil as it comes from the well.

DILUENT: A liquid used to dilute bitumen to the point where it will flow.

DISTILLATE (CONDENSATE): Liquid hydrocarbons produced with natural gas which are separated from the gas by cooling and various other means.

DRAGLINE: A mining machine which drops a heavy toothed bucket on a cable from the end of a boom into the oil sand, then drags the bucket through the deposit, scooping up the sand. Once full, the bucket is raised and emptied onto a windrow.

ENHANCED RECOVERY: Recovery of oil by the implementation of an artificially improved depletion process.

ESTABLISHED RECOVERABLE RESERVES: Those reserves recoverable under current technology and present and anticipated economic conditions, specifically proved by drilling, testing or production, plus that judgment portion of contiguous recoverable reserves that are interpreted to exist, from geological, geophysical or similar information, with reasonable certainty.

EXTRACTION: The process by which the bitumen is separated from the sand, water and other impurities.

FLEXI-COKING: A patented process for converting fluid coke into a usable fuel gas.

FLUID COKE: Coke in the form of small granules which can be aerated, blown through a pipe, and will flow like a liquid.

FRACTION: A separate, identifiable part of crude oil; the product of refining or distillation. Crude oil is divided into hundreds of fractions - gases, fuels, oils, asphalts and coke.

FRACTIONATION: The process by which bitumen is separated into its fractions.

FROTH: A mixture of air, water and bitumen which rises to the surface of the primary separation vessel.

HOT WATER FLOTATION: The process by which oil sand is mixed with hot water, then aerated. The heavier-than-water bitumen clings to air bubbles which carry it to the surface.

HYDROCARBONS: Organic chemical compounds of hydrogen and carbon atoms which form the basis of all petroleum products.

HYDROCRACKING: A refining process for reducing heavy hydrocarbons into lighter fractions, using hydrogen and a catalyst.

HYDROTREATING: Hydrocracking.

INITIAL VOLUME IN-PLACE: The gross volume of crude bitumen or oil calculated or interpreted to exist in a reservoir before any volume has been produced.

INITIAL ESTABLISHED RESERVES: Established reserves prior to the start of any production.

In situ: In-place.

METAL CATALYST CARBONYL: A chemical compound used to increase the speed of chemical reactions. A carbonyl in combination with heavy metals forms compounds which are highly toxic because they decompose to release carbon monoxide when absorbed by the body.[16]

MINEABLE OIL SAND: Oil sand which can be recovered by surface mining methods.

MUSKEG: A water-soaked form of peat, sphagnum moss.

NON-CONVENTIONAL CRUDE OIL: Heavy crude oil which, while lighter than bitumen, cannot be recovered by conventional methods from a well at a commercial rate.

OIL SANDS: Sand and other rock material which contain crude bitumen.

OIL SANDS DEPOSIT: A natural reservoir containing or appearing to contain an accumulation of oil sands, separated or appearing to be separated from any other such accumulation.

OVERBURDEN: The layer of sand, gravel and shale which overlies the oil sands.

PETROCHEMICALS: Chemicals made from crude oil.

PETROLEUM: In a general sense, all hydrocarbons; usually, crude oil.

PILOT PLANT: A small model plant for testing processes under actual production conditions.

PRIMARY SEPARATION VESSEL: The vessel in which the first separation of bitumen from sand takes place.

PRODUCTION WELL: A well which produces oil.

PROVEN RECOVERABLE RESERVES: Reserves which have been proven through production or testing to be recoverable with existing technology and under present economic conditions.

RECLAMATION: Returning disturbed land to a productive state.

[16]Gessner G. Hawley. The Condensed Chemical Dictionary. Van Nostrand Reinhold, 1977, p.165.

REMAINING ESTABLISHED RESERVES: Initial reserve less cumulative production.

SATURATION: A measure of the extent to which pore space in the sand or rock is occupied by bitumen or oil.

SLURRY: A thick, liquid mixture of oil sand and water.

SOUR WATER: Water which contains acid gases, generally hydrogen sulfide.

SYNTHETIC CRUDE OIL: Crude oil produced by upgrading bitumen.

TAILINGS: Waste products from the mining, extraction and upgrading processes.

TAILINGS POND: An enclosure to contain tailings.

ULTIMATE POTENTIAL: An estimate of the initial established reserves which will have become developed in an area by the time all exploratory and development activity has ceased, having regard for the geological prospects of that area and anticipated technology and economic conditions. Ultimate potential includes cumulative production, remaining established reserves and future additions through extensions and revisions to existing pools and the discovery of new pools.

Ultimate potential = Initial established reserves + additions to existing reserves + future discoveries.

UPGRADING: The conversion of bitumen into synthetic crude oil.

VISCOSITY: The ability of a liquid to flow. The lower the viscosity, the more easily the liquid will flow.

Source: McRory, Robert E. Oil Sands and Heavy Oils of Alberta. Alberta Energy and Natural Resources, 1982, p. 91-93.

APPENDIX A

LOST-TIME CLAIMS TABLES

TABLE A1

NUMBER AND PERCENT DISTRIBUTION OF CLAIMS BY FINAL DISPOSITION - OIL SANDS INDUSTRY*, ALBERTA 1978 - 1983

	MEDICAL AID		LOST TIME		TOTAL	
	#	%	#	%	#	%
1978	602	87.4	87	12.6	689	100.0
1979	650	87.2	95	12.8	745	100.0
1980	757	86.9	114	13.1	871	100.0
1981	643	79.1	170	20.9	813	100.0
1982**	-	-	214		-	-
1983	-	-	160		-	-
TOTAL	2652		840		3492	

*Includes three industries:

1. 6600 - Processing of oil from tar sands.
2. 6601 - Tar Sand Research & Development.
3. 6602 - Bituminous sand mining for oil.

**Complete information on medical aid claims is not available in 1982 and 1983 due to changes in reporting requirements. Hence, the overall total for the six years does not include 1982-1983 medical aid claims.

SOURCE: Workers' Compensation Board Statistical Master File Tapes, 1978-1983. Totals include all new claims finalized as of March 31 of the following year.

TABLE A2

LOST TIME CLAIMS IN THE OIL SANDS INDUSTRY
BY ACCIDENT TYPE,
ALBERTA 1978 - 1983

ACCIDENT TYPE		#	%
Overexertion			
Lifting objects		90	10.8
NEC*		54	6.5
Pulling or pushing objects		23	2.7
Other		10	1.2
	Sub-Total	177	21.1
Bodily Reaction			
Involuntary motions		72	8.6
Voluntary motions		67	8.0
	Sub-Total	139	16.6
Struck By			
Falling objects		57	6.8
Objects hoisted, handled, conveyed		26	3.1
Other		27	3.2
	Sub-Total	110	13.1
Fall from elevation		91	10.9
Fall on same level		73	8.7
Contact with toxic substances		53	6.3
Caught in, under or between		52	6.2
Struck against		40	4.8
Rubbed or abraded		36	4.3
Temperature extremes		34	4.0
Vehicle accidents		28	3.3
Other		4	0.5
	TOTAL	837**	99.8***

*NEC = Not elsewhere classified.
**Data were not available for three claims.
***Inexact due to rounding.

SOURCE: Workers' Compensation Board Statistical Master File Tapes, 1978-1983. Totals include all new claims finalized as of March 31 of the following year.

TABLE A3

LOST TIME CLAIMS IN THE OIL SANDS INDUSTRY
BY SOURCE OF INJURY,
ALBERTA 1978 - 1983

SOURCE OF INJURY		#	%
Working Surface			
Ground (outdoors)		38	4.6
Floor (bldg., mine, vehicle)		24	2.9
Other		77	9.3
	Sub-Total	139	16.8
Bodily Motion			
Free movement (running, climbing, stretching, etc.)		62	7.5
Slippery surfaces		27	3.3
Other		50	6.0
	Sub-Total	139	16.7
Metal Items			
Metal items, NEC*		53	6.4
Pipe, NEC		24	2.9
Metal structural members		27	3.3
Other		21	2.5
	Sub-Total	125	15.1
Vehicles		44	5.3
Boxes, containers		44	5.3
Handtools, unpowered		40	4.8
Machines		36	4.3
Chemicals		31	3.7
Particles, unidentified		20	2.4
Boilers, pressure vessels		16	1.9
Flame, fire, smoke		13	1.6
Other		183	22.0
	TOTAL	830**	99.9***

*NEC = Not elsewhere classified.
**Data were not available for 10 claims.
***Inexact due to rounding.

SOURCE: Workers' Compensation Board Statistical Master File Tapes, 1978-1983. Totals include all new claims finalized as of March 31 of the following year.

TABLE A4

LOST TIME CLAIMS IN THE OIL SANDS INDUSTRY
BY PART OF BODY INJURED,
ALBERTA 1978 - 1983

PART OF BODY	#	%
Back	254	30.2
Leg	94	11.2
Ankle, foot	84	10.0
Other trunk	75	8.9
Multiple parts	61	7.3
Eyes	59	7.0
Fingers	58	6.9
Other head, neck	41	4.9
Arm	34	4.0
Wrist, hand	33	3.9
Respiratory system	17	2.0
Other	30	3.6
TOTAL	840	99.8*

*Inexact due to rounding.

SOURCE: Workers' Compensation Board Statistical Master File Tapes, 1978-1983. Totals include all new claims finalized as of March 31 of the following year.

TABLE A5

LOST TIME CLAIMS IN THE OIL SANDS INDUSTRY
BY OCCUPATION OF CLAIMANT,
ALBERTA, 1978 - 1983

OCCUPATION	#	%
Mechanics		
Industrial, construction machinery mechanics and repairmen	136	18.8
Other mechanics	12	1.7
Sub-Total	148	20.5
Construction		
Excavating & related, NEC*	48	6.6
Pipefitting, plumbing & related	38	5.3
Electricians & repairmen	31	4.3
Other	28	3.9
Sub-Total	145	20.1
Mining		
Mining and quarrying	58	8.0
Mining & quarrying - labouring & other elemental work	58	8.0
Other	19	2.6
Sub-Total	135	18.7
Welding & flame cutting occupations	64	8.9
Distilling, subliming & carbonizing chemicals & related material	31	4.3
Freight handlers	24	3.3
Chemicals, petroleum processing	29	4.0
Other	146	20.2
TOTAL	722**	100.0

*NEC = Not elsewhere classified.
**Data were not available for 118 claims.

SOURCE: Workers' Compensation Board Statistical Master File Tapes, 1978-1983. Totals include all new claims finalized as of March 31 of the following year.

TABLE A6

LOST TIME CLAIMS IN THE OIL SANDS INDUSTRY
BY NATURE OF INJURY,
ALBERTA 1978 - 1983

NATURE OF INJURY	#	%
Sprains, strains	401	47.7
Contusion, crushing, bruise	130	15.5
Fracture	65	7.7
Laceration, cut, puncture	44	5.2
Scratches, abrasions	38	4.5
Other diseases	33	3.9
Multiple injuries	32	3.8
Burn or scald	30	3.6
Systemic poisoning - respiratory system	17	2.0
Burn - caustic chemicals or fumes	19	2.3
Electric arc, welding flash	10	1.3
Other injury	21	2.5
TOTAL	840	99.9*

*Inexact due to rounding.

SOURCE: Workers' Compensation Board Statistical Master File Tapes, 1978-1983. Totals include all new claims finalized as of March 31 of the following year.

TABLE A7

LOST TIME CLAIMS IN THE OIL SANDS INDUSTRY
BY AGE AT TIME OF ACCIDENT,
ALBERTA 1978 - 1983

AGE CATEGORY	#	%
15 - 24 years	180	21.4
25 - 34 years	355	42.3
35 - 44 years	208	24.8
45 - 54 years	80	9.5
55 - 64 years	16	1.9
65 years and over	1	0.1
TOTAL	840	100.0

SOURCE: Workers' Compensation Board Statistical Master File Tapes, 1978 - 1983. Totals include all new claims finalized as of March 31 of the following year.

TABEL A8

LOST TIME DISEASE CLAIMS IN THE OIL SANDS INDUSTRY, 1978 - 1983

NATURE OF DISEASE	#	%
Burn - caustic chemicals or fumes	19	25.7
Systemic poisoning - respiratory system	17	23.0
Synovitis, Tenosynovitis	10	13.5
Electric arc, welding flash	10	13.5
Systemic poisoning, NEC*	7	9.5
Bursitis	5	6.8
Hearing loss or impairment	3	4.1
Other	3	4.1
TOTAL	74	100.2**

Note: the above disease categories are based on the WCB disease classifications for lost time claims.

*NEC = Not Elsewhere Classified.
**Inexact due to rounding.

SOURCE: Workers' Compensation Board Statistical Master File Tapes, 1978 - 1983. Totals include all new claims finalized as of March 31 of the following year. Includes all lost time claims classified by the WCB as an occupational illness.

TABLE A9

LOST TIME CLAIMS IN THE OIL SANDS INDUSTRY
BY LENGTH OF TIME EMPLOYED WITH THIS EMPLOYER,
1978 - 1983

LENGTH OF TIME	#	%
Less than 1 month	22	2.8
1 Month to Less than 6 Months	108	14.0
6 Months to Less than One Year	101	13.1
1 Year or More	542	70.1
TOTAL	773*	100.0

*Data were not available for 67 claims.

SOURCE: Workers' Compensation Board Statistical Master File Tapes, 1978 - 1983. Totals include all new claims finalized as of March 31 of the following year. Includes all lost time claims classified by the WCB as an occupational illness.

APPENDIX B

OIL SANDS PRODUCTION

TABLE B1

ALBERTA OIL SANDS PRODUCTION (1978 - 1983)
(CUBIC METERS M^3)

	1978	1979	1980	1981	1982	1983
SUNCOR						
Bitumen	3,607,473	3,297,642	3,851,069	2,531,384	2,943,874	3,755,640
Synthetic Crude Oil[1]	2,628,993	2,424,777	2,759,729	1,548,198	1,011,030	2,275,369
Distillate*	5,092	75,733	0	191,789	973,883	502,904
SYNCRUDE						
Bitumen[2]	1,101,493	4,112,274	6,305,853	6,230,259	6,450,389	7,977,737
Synthetic Crude Oil	710,374	3,128,468	4,878,800	4,920,078	5,272,195	6,316,871
Distillate*	-	-	-	-	-	159,476
PROVINCIAL TOTAL						
Bitumen	4,708,966	7,409,916	10,156,922	8,761,643	9,394,263	11,733,37
Synthetic Crude Oil[3]	3,344,459	5,629,078	7,638,529	6,660,065	7,257,108	9,254,62

CONVERSION FACTOR: $1m^3$ = 6.2923 barrels of oil.

*Indicates it is not hydrotreated.

[1]Total includes diesel fuel used at Suncor.

[2]Total includes material recycled at Syncrude Plant.

[3]Total figure for synthetic crude oil production includes distillate produced at Suncor.

SOURCE: Energy Resources Conservation Board, Alberta, Canada.

APPENDIX C

HEALTH AND SAFETY PROGRAMS (SYNCRUDE AND SUNCOR)

Health and Safety Programs (Syncrude and Suncor)

Syncrude

Syncrude's Hygiene Department is undertaking a number of programs aimed at controlling health hazards in the oil sands industry. In addition to the Syncrude-sponsored toxicity study previously mentioned, the following programs have been developed.

Hearing Conservation Program

A hearing conservation program has been set up at Syncrude. Information from a noise survey of the plant was used to designate each area by a colour code according to the amount of noise produced. New staff receive hearing tests in the medical centre to establish a base hearing level for each employee. The hygienist chairs safety team meetings on the hearing program once a month.

Coke Dust Program

Coke dust, a fine black dust which is largely carbon, is a by-product of the cracking of bitumen.[11] A coke dust program, initiated by Syncrude in March, 1984, surveyed and identified the "high risk" areas of the plant. The program is divided into three phases: 1) medical monitoring, 2) education and 3) protective equipment.

[11]According to Ahmet Ayalp, Syncrude, estimates of the carbon content of coke dust range from 78% to 80%.

Medical Monitoring - All "high risk" employees receive medical examinations including pulmonary function tests and x-rays.

Education - This phase involves a discussion with workers on the toxicity of the dust, the personal protective masks to be worn and the engineering controls in effect.

Protective Equipment - Workers are required to wear masks.

Operators are exposed to coke dust for variable amounts of time but the total exposure in one day would be about 1.5 hours. Maintenance workers are intermittently exposed to dust for longer periods. The American Petroleum Institute is presently conducting studies on the health effects of coke dust. The studies are evaluating its carcinogenic and fibrogenic potential.

In addition, the following list outlines Syncrude's major industrial hygiene and employee education programs:

INDUSTRIAL HYGIENE PROGRAM*

- Hazard Assessment
- Engineering Controls
- Exposure Risk Assessment and Exposure Monitoring
- Employee Education
- Management of Hazardous Chemicals
- Personal Protective Equipment
- Hygiene Facilities
- Record Keeping
- Extremes of Temperature Exposures
- Radiation Exposure

* Source: Syncrude Canada.

EMPLOYEE EDUCATION PROGRAM

- Initial Training of New Employees
- Continued Education
- Periodic Health and Safety Meetings
- Booklets
- Safety Orientation
- H_2S Awareness and Procedures Working with H_2S
- Air Supplied Respiratory Protective Equipment Training
- Hearing Conservation Program Education
- Coke Dust & Respiratory Surveillance Program Education
- Material Health and Safety Information
- Gas Testing Procedures
- Safe Work Permit Procedures

SAFE HANDLING PROCEDURES

- Avoid Skin and Eye Contact
- Avoid Inhalation of Gases, Vapours and Mists
- Good Housekeeping
- Good Personal Hygiene Practice
- Personal Protective Equipment
- Degree of Exposure Classification
- Warning Signs
- Regular Maintenance and Repair

PERSONAL PROTECTIVE EQUIPMENT

- Respiratory Protection
- Hearing Protection
- Eye Protection
- Skin Protection

Suncor Oil Sands Group (O.S.G.)

The Industrial Hygiene Department has developed a program to minimize potential health hazards to Suncor's employees. An extensive cataloging of all materials, chemicals and physical agents at the O.S.G. was developed. A risk assessment was performed on all operating areas of the plant to arrive at a long range air monitoring strategy. The Industrial Health Centre has developed a medical monitoring program to check employees for potential health risks. The following programs have been developed at the Oil Sands Group.

Employee Education

A catalogue has been developed for each area that includes a listing of all materials and material safety data sheets. These materials are reviewed by the employees at regular monthly safety meetings. Proper handling procedures and the use of personal protective equipment are discussed to ensure proper procedures are followed whenever chemicals are handled.

Medical Monitoring

All employees receive pre-placement and exit medical evaluations. Such testing includes x-ray, audiogram, spirometry and electro-cardiogram. In addition, all employees are required to receive annual medical examinations.

Hearing Conservation Program

All new employees receive pre-placement baseline audiograms. High noise areas have been sign posted as mandatory hearing protection areas. Employees are given a choice of either ear plugs or ear muffs for protection.

Audiograms are required on an annual basis. The risks of exposure to high noise without proper protection are reviewed frequently with the employees and the use of hearing protection is enforced. The employees' 8-hour and 12-hour exposure to noise is being developed with the use of personal dosimetry.

Hydrogen Sulphide Awareness Program

Employees with potential exposure to hydrogen sulphide gas are required to receive the hydrogen sulphide awareness training program. The certified training is renewed every three years. On a regular basis, training is reviewed on the use of resuscitators, breathing air and man-down rescue techniques. Breathing air equipment is mandatory for all work where the potential for exposure to hydrogen sulphide gas exists.

Plant areas with high potential for exposure to hydrogen sulphide gas have stationary air monitors strategically located to detect any hazardous area. The monitors set off alarms both in the control room as well as that particular area. Operators also have portable gas monitors to assist them in detecting hazardous areas.

Indoctrination Training

It is mandatory for all Suncor and contract personnel to be formally instructed in the O.S.G. Health and Safety Policies. Such training includes the use of self-contained breathing apparatus and air filtering respiratory protective equipment. Such training is required before access to operating areas is allowed. The training is repeated annually.